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# **U.S. Army Corps of Engineers Fort Worth District**

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Final  
Lake Belton Acoustic Doppler  
Current Profiler Survey  
Field Sampling Plan

**Bosque and Leon River Watersheds Study**

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January 2003



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## ACRONYMS

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ADCP	Acoustic Doppler Current Profiler
BRA	Brazos River Authority
CQC	Contractor Quality Control
CSM	Conceptual Site Model
DGPS	Differential Global Positioning System
DQCR	Daily Quality Control Report
DQOs	Data Quality Objectives
FSP	Field Sampling Plan
GPS	Global Positioning System
MWH	MWH Americas, Inc.
NWIRP	Naval Weapons Industrial Reserve Plant
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
SAP	Sampling and Analysis Plan
SSHP	Site Safety and Health Plan
USACE	U.S. Army Corps of Engineers Fort Worth District
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey

## 1.0 INTRODUCTION

This Acoustic Doppler Current Profiler (ADCP) Survey Field Sampling Plan (FSP) is a component of the *Sampling and Analysis Plan - Bosque and Leon River Watersheds Study* (SAP; MWH Americas, Inc. 2002a). The SAP includes a Quality Assurance Project Plan (QAPP), a Site Safety and Health Plan (SSHP), and task-specific FSPs. This and other task-specific FSPs are prepared as addenda to the overall SAP to describe the project requirements for the field investigations associated with the Bosque and Leon River Watersheds Study.

This FSP was prepared for the U.S. Army Corps of Engineers Fort Worth District (USACE) by its environmental contractor, MWH Americas, Inc. (MWH), through authorization provided in contract DACW57-97-D-004, Task Order DY01, Modification No. 003. This FSP has been prepared in accordance with the USACE Statement of Work dated May 7, 2002, and the *Requirements for the Preparation of Sampling and Analysis Plans* (EM 200-1-3; USACE, 2001).

### 1.1 PROJECT DESCRIPTION AND BACKGROUND

The purpose of the USACE Bosque and Leon River Watersheds Study is to assess the impact of perchlorate releases associated with the former Naval Weapons Industrial Reserve Plant at McGregor, Texas (NWIRP McGregor). Specifically, the USACE study is assessing the potential human and environmental exposure to perchlorate in the Lake Belton and Lake Waco study area. NWIRP McGregor is located approximately 20 miles southwest of Waco, Texas, as shown on Figure 1-1.

A conceptual site model (CSM) was prepared to provide a preliminary conceptual understanding of potential human and environmental exposures to perchlorate in the Lake Belton and Lake Waco study area (MWH, 2002b). The CSM identified data gaps in the current understanding of perchlorate migration and exposure within the study area, and identified additional investigation activities aimed at filling such data gaps. An ADCP survey is one of the field investigation activities proposed to fill certain data gaps identified in the CSM.

Please refer to the SAP for a historical summary of NWIRP McGregor, a description of the integrated multi-disciplinary project team, a description of the USACE perchlorate study area, the environmental setting, and a brief summary of previous environmental investigations in the study area. Details regarding the historical use, and investigation history at former NWIRP McGregor also are included in the *Final Conceptual Site Model Bosque and Leon River Watersheds Study* (MWH, 2002b).

## **1.2 ACOUSTIC DOPPLER CURRENT PROFILER BACKGROUND**

ADCP was first shown to be a promising tool for determining river current velocity in 1982 (USGS, 2001). ADCP equipment is now used to measure current velocity in oceans, lakes, rivers, and estuaries. ADCP can be used over a wide range of depths and varying conditions making it a powerful tool for the measurement of current velocity in settings where conventional discharge measurements could not previously be performed.

The ADCP equipment measures water velocity by using a principle of physics known as the Doppler shift, where the change in frequency of a source of sound is related to both the velocity of the source and the observer. ADCP functions by emitting sound waves from near the water surface to the bottom of the water body. The ADCP equipment bounces an ultrasonic sound pulse off small particles of sediment and other material being carried by the current in the water column (collectively referred to as backscatters) and records the return echo from the acoustic backscatters. Upon receiving the return echo, the ADCP's onboard signal processing unit calculates the Doppler shift and thus determines the velocity of the backscatters which is equal to the velocity of the water.

For this study an ADCP will be attached to a boat and used to determine current velocity at 21 transects, as shown on Plate 1, by motoring across Lake Belton. ADCP operation requires a significant amount of operator training. The operator must have some understanding of acoustic physics, a working knowledge of ADCP operation, experience with the manufacturer's discharge measurement software, and boating techniques and safety experience. It is anticipated that an experienced person will operate the ADCP instrument and that the Brazos River Authority (BRA) and MWH will provide the boat and manpower necessary to complete this study.

## **1.3 FIELD SAMPLING PLAN SCOPE AND STUDY OBJECTIVES**

This FSP describes the field activities to be performed and defines the procedures and methods to be used to collect field measurements during all ADCP surveys. A total of four ADCP measurements will be obtained at all transects, one during each season of the year. ADCP measurements will be repeated on a seasonal basis in order to better understand lake current changes throughout the year and to ascertain what effect changing flow patterns may have on perchlorate fate and transport. The ADCP survey is limited to Lake Belton based on the current assumption that Lake Waco is a well-mixed, homogeneous environment, both because of its shallow configuration and the presence of a mechanical aeration system.

## 1.4 DOCUMENT ORGANIZATION

The remainder of this FSP consists of:

- Section 2.0 Field Program. Includes the ADCP survey rationale and data quality objectives (DQOs), ADCP equipment and procedures, and all other operations associated with the field sampling program.
- Section 3.0 Health and Safety Program. References the SSHP component of the SAP. It includes all safety precautions applicable to the field activities described in this FSP.
- Section 4.0 Quality Control. Includes the quality control that is specific to this field program.

## **2.0 FIELD PROGRAM**

This section describes the field program rationale and DQOs; field documentation procedures; and equipment and procedures for the ADCP survey.

### **2.1 QUALITY ASSURANCE PROJECT PLAN**

All data for this project will be collected in accordance with the QAPP, which along with the SSHP and this FSP, is a component of the SAP (MWH, 2002a). The QAPP presents the Quality Assurance/Quality Control (QA/QC) protocols that will be used to meet the DQOs of this field program. The QAPP will be referenced throughout this document to support the data collection procedures presented herein. The types of data to be collected during this field program and their intended uses are presented in Table 2-1.

### **2.2 DATA QUALITY OBJECTIVES**

DQOs have been developed for each field task in this field program using the seven-step process as outlined in the *Guidance for the Data Quality Objectives Process, EPA QA/G-4* (USEPA, 1994) and additional guidance as provided in *Data Quality Objectives for Hazardous Waste Site Investigations, EPA QA/G-4HW* (USEPA, 2000). The steps in this process are:

- State the Problem
- Identify the Decision
- Identify the Inputs to the Decision
- Define the Boundaries of the Study
- Develop Decision Rules
- Specify Tolerable Limits on Decision Errors
- Optimize the Design for Obtaining Data.

The DQOs developed for the ADCP survey field tasks are presented in Table 2-2.

### **2.3 FIELD DOCUMENTATION**

All information pertinent to the field activities described herein will be entered directly into a field logbook and on project-specific field forms. The field logbook will be maintained throughout all field activities and will consist of a weatherproof, bound, survey-type book, with non-removable, numbered pages.

All activities performed during the ADCP survey and any deviations from this work plan will be recorded in detail in the field logbook. At a minimum, the date, weather conditions, personnel on site, type of activities being performed, and any unusual

conditions encountered during the investigation will be recorded in the logbook. Corrections to erroneous data will be made by crossing a single line through the entry and entering the correct information. Unused portions of the logbook pages will be crossed out, signed, and dated at the end of each work day. Language used will be objective, factual, and free of personal opinions. Hypotheses for observed phenomena may be recorded; however, they must be clearly indicated as such and only relate to the subject observation. The field forms that are applicable to this project include Daily Quality Control Reports and Tailgate Safety Meeting Forms. Field forms will become part of the project record. Sample field forms are provided in Appendix A of this work plan.

In addition to written records, photographs also will be taken as necessary to supplement written descriptions of field activities entered in the field logbook and on field forms. Photographs will be included in project reports when appropriate, and will be stored with the permanent project files.

## **2.4 ACOUSTIC DOPPLER CURRENT PROFILER SURVEY PROCEDURES**

### **2.4.1 Introduction**

The field procedures for the ADCP survey will be conducted in accordance with the guidelines presented in Appendix B. The applicable guidelines in Appendix B include:

- WorkHorse Read This First Guide
- WorkHorse Rio Grande ADCP User's Guide
- WorkHorse Sentinel ADCP User's Guide
- WinRivers User's Guide
- United States Geological Survey Open-File Report 01-1
- United States Geological Survey Open-File Report 95-701

A boat will be used to complete 21 ADCP transects across Lake Belton, as shown on Plate 1, during each of the four ADCP surveys. The ADCP will be installed at least 3 inches below the water surface. The mount used to attach the ADCP to the boat should be designed to withstand the forces of water resulting from the boat's movement during the ADCP survey. The mount should be designed so that the ADCP can be quickly raised or rotated out of the water for moving from one transect to the next. The ADCP must not be mounted near steel or any other ferrous material that would affect the functioning of the internal compass. For this reason, a boat with a steel hull will not be used.

ADCP data will be collected continuously across each transect from the lake surface to the lake bottom throughout the entire transect. ADCP data generated will produce a current velocity profile from the lake surface to the bottom of the lake at all points across the transect. The resultant ADCP data can be displayed in a number of ways. It will be possible to display the magnitude and direction of current perpendicular to the transect



for the entire depth profile at each transect. Similarly, it is possible to display the current velocity as a product of three velocity vectors for the entire depth profile. Displays of current velocity at discrete depth intervals also can be portrayed. A review of the data prior to presentation will be made in order to determine the best methods for display and interpretation.

An experienced individual will operate the ADCP equipment and an experienced boat operator will control the boat in order to ensure representative and accurate ADCP data. Each transect will be completed in order to obtain depth and current profiling data. An ADCP pre-run will be performed at the beginning of each field day to verify that all equipment is functioning properly. The distance from shore will be obtained with a range finder at both the start and end of each transect. Each transect will be performed by guiding the boat along the pre-determined transects (at a rate no greater than 6 knots). The locations of the transects may be changed based on field conditions, observations, or lack of accessibility by boat, but the geographic positioning system (GPS) coordinates for both the starting and end points of each transect will be recorded. The ADCP data will be checked for completeness and accuracy at the completion of each transect prior to moving to the next transect. Details regarding the ADCP locations and rationale and equipment and procedures are presented below.

#### **2.4.2 Locations and Rationale**

The ADCP survey will include 21 ADCP transects across Lake Belton as shown on Plate 1. The overall rationale for the selected ADCP transects is to provide data that can be used to identify flow patterns within the lake and determine if deep-water currents along the thalweg of the old river channel could provide a preferential flow path for perchlorate that may be entering the lake. The proposed number and locations of the transects is based on providing an approximately even distribution along the length of the lake. In addition, three transects are located adjacent to the Bell County WCID No. 1, Blue Bonnet, and City of Gatesville water intake structures. The beginning and end point coordinates, length, and maximum depth for all ADCP transects are included in Table 2-3. The field team will document the actual GPS coordinates of all transects during the ADCP survey.

#### **2.4.3 Equipment and Procedures**

**Acoustic Doppler Current Profiler Equipment.** A 600 kHz Rio Grande or Sentinel Workhorse with bottom tracking capability will be used for the ADCP survey. Both of these models will produce similar results in the depths observed at Lake Belton. Manufacturers' and users' guides are included in Appendix B. The following equipment is needed to complete the ADCP survey:

- 600 kHz Rio Grande or Sentinel ADCP Workhorse with bottom-tracking capability

- Differential GPS (to be used if bottom-tracking is hindered due to high sediment conditions)
- Power supply and communications interface
- Velocity profiling and measurement software
- Manufacturer's documentation.

**Additional Equipment.** The following ancillary equipment will be needed during the ADCP survey:

- Boat (non-steel hull)
- Mounting assembly for connecting ADCP and GPS equipment to the boat
- Laptop computer
- Range finder or method for estimating distance to shore.
- Handheld GPS

**Pre-Survey ADCP Activities.** Prior to deployment of the ADCP, the Sentinel or Rio Grande Workhorse compass will be calibrated on land according to manufacturers' guidelines. Following compass calibration, the ADCP will be attached to the side of the boat and set at a depth below the water surface based on manufacturers' guidelines. The depth to which the ADCP is installed below the water surface will be recorded. The ADCP will be programmed, operated, and maintained according to manufacturers' guidelines by an experienced professional.

**ADCP Survey Activities.** A pre-run will be performed prior to beginning the first transect each day to verify the ADCP and data collection equipment are functioning correctly. Data acquisition will begin by determining the distance from shore using a range finder, or similar equipment, and recording the transect starting point location using GPS. Once data acquisition has begun, the boat will move slowly (no greater than 6 knots) along the transect and across the lake toward the end point. The distance from shore and GPS location will be determined at the transect endpoint. Following data acquisition, the ADCP will be turned off and pulled out of the water and the data will be checked for quality and accuracy prior to moving to the next transect. A temperature profile will be obtained at the deepest point of the lake along each transect. Temperature measurements will be recorded at ten-foot intervals from the surface to the bottom of the lake. ADCP survey activities will be halted if the boat and ADCP equipment operators determine that wave and wind action is unsafe or will prevent the collection of representative and accurate data.

## **2.5 CONTRACTOR QUALITY CONTROL**

The three-phase Contractor Quality Control (CQC) program will be implemented during the performance of each ADCP survey. Details regarding the three phase CQC program are included in Section 6.0 of the SAP.

### **3.0 HEALTH AND SAFETY PROGRAM**

All personnel involved with the field activities described in this FSP shall follow the *Site Safety and Health Plan – Bosque and Leon River Watersheds Study* (SSHP; MWH, 2002a). The SSHP was prepared specifically for the field investigations that will support the USACE Bosque and Leon River Watersheds Study, and includes the health and safety procedures and protocols for the Acoustic Doppler Current Profiler survey. The Activity Hazard Analysis that is specific to the Acoustic Doppler Current Profiler survey is summarized in Table 1-1c of the SSHP.

## **4.0 QUALITY CONTROL**

This section is a summary of quality control procedures that will be followed during the ADCP survey field program, including daily quality control reports and final reporting requirements. The overall quality program for all field investigations that will be implemented to support the USACE Bosque and Leon River Watersheds Study is presented in the *Quality Assurance Project Plan – Bosque and Leon River Watersheds Study* (QAPP; MWH, 2002a)

### **4.1 ADCP QUALITY CONTROL**

ADCP quality control procedures will be performed according to manufacturers' guidelines and the *Quality Assurance Plan for Discharge Measurements Using Broadband Acoustic Doppler Current Profilers* (USGS, 1995). A copy of this plan is included in Appendix B. A pre-run will be performed prior to beginning the first transect each day to verify the ADCP and data collection equipment are functioning correctly. During each seasonal survey, one (1) of the 21 transects will be repeated three times as a QA/QC measure. The raw data will be copied onto a disk as a backup in the event of damage to the computer's internal hard drive. Following each seasonal ADCP survey, wind and weather data will be downloaded from the nearest weather station and used in conjunction with ADCP data to ascertain any relationship between lake currents and wind. The use of the weather station data is not mandatory, but the review of the data will serve as an additional QA/QC measure in the event that wind or weather has any effect on the collection of ADCP data. In addition, review of the wind and weather data may also provide insight into the presence of lake currents or any relationship between wind and lake currents.

### **4.2 DAILY QUALITY CONTROL REPORTS**

Daily Quality Control Reports (DQCRs) will be prepared for every day field work is performed. DQCRs are field reports that summarize daily activities and help project personnel track quality control activities. These reports will include location(s) of work, weather conditions and temperatures, work performed, results of any inspections/tests performed, the individuals performing the inspections/tests, equipment calibration procedures, problems identified and associated corrective actions taken, any instructions received from the USACE Project Manager, and any general comments. A DQCR form is included in Appendix A.

### **4.3 REPORTING REQUIREMENTS**

Project activities will be documented in the quarterly updates regarding the data that were collected during the ADCP survey field activities. A technical memorandum will be prepared each quarter that discusses the results and makes recommendations for refining the sampling/measurement criteria. The text will also include a discussion of field methods and procedures that deviated from those proposed in this document (if any). All ADCP survey data will be presented with a narrative that will summarize the quality and usefulness of the data.

## 5.0 REFERENCES

- MWH Americas, Inc., 2002a. *Sampling and Analysis Plan – Bosque and Leon River Watersheds Study*; comprises the sampling and analysis plan (SAP), quality assurance project plan (QAPP), site safety and health plan (SSHP), and the task-specific field sampling plans (FSPs). Prepared for the U.S. Army Corps of Engineers, Fort Worth District. July 2002.
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